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Simple Aids for the High School Chemistry Course

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I. Introduction

A. Preview

Chemistry teachers, especially those in the first year of experience, are usually not acquainted with the practical methods of handling meager equipment which they find in the average high-school chemistry department. In their college training they have had access to technical and modern equipment and have not had to build or assemble their own equipment and apparatus to work some of the experiments necessary to the teaching of chemistry. Due to this lack of training and its accompanying difficulties, teachers many times wonder why some of their experiments fail to work satisfactorily. Unless their teaching initiation is under the careful and watchful supervision of a highly capable superintendent or principal, they soon become discouraged and their success is likely to be greatly impeded.

In many high schools in Indiana boys and girls graduate each year without training in some of the fundamentals of chemistry. Many of them enter college and either select chemistry or it is selected for them as one of their subjects. They soon become lost in a maze which, in many cases, proves too difficult for them to master, and failure soon follows. It is the duty of trustees, school boards, and superintendents of the high schools of Indiana to provide facilities for the adequate training in chemistry since it is so vital a subject in the field of science. However, school officials have hesitated in offering chemistry in their schools, and have dodged the issue by saying that the course would be prohibitive because of lack of school funds. Perhaps the reason for their belief that such a course would be expensive has been caused by the short insight of some previous teacher or administrator. With the common difficulties in mind as expressed, this bulletin was undertaken for purposes cited in the following paragraph.

B. Purpose of the Study

This study was made to fulfill three major purposes:

1. To place in the hands of chemistry teachers a bulletin to aid them in collecting and building simple apparatus, as well as making use of chemicals brought from home by the students to help defray expenses.

2. To place in the hands of school officials a bulletin to show that chemistry can be offered with minimum expense.

3. To stimulate chemistry teachers in sending other suggestions[1] to Indiana State Teachers College to be incorporated in a future bulletin similar to this one.

C. STATEMENT OF THE PROBLEM

The problem of this study was to collect and organize in bulletin form some simple aids in the teaching of high-school chemistry.

D. SOURCE OF INFORMATION

The units of the course of study set forth in this bulletin were obtained from an article written by four experts in the field of chemistry.[2] The units and experiments meet the requirements of the course of study for Indiana.[3]

The experiments, including the list of apparatus and chemicals to be used, were obtained from an unpublished master's thesis written by J. Carter Eavey at Indiana State Teachers College in 1935.[4] The experiments have been performed by Eavey in the laboratory and are reliable in every respect.

The units presented were prescribed by Hopkins,[5] Mattern,[6] Segerblom,[7] and Gordon,[8] who represent the committee on correlation of high-school with college chemistry as appointed by the Division of Chemical Education of the American Chemical Society.

The authors of this bulletin are experienced teachers.

II. Course of Study and Accompanying Experiments

The following units were selected from an article mentioned in the first part of this bulletin;[9] the experiments were taken from the thesis which was also mentioned in the introduction.[10]

Unit I—Introduction
- Experiment 1. Changes in matter.

Unit II—Dispersions
- Experiment 2. To show how pure water can be obtained.
- Experiment 3. Solution and suspension.
- Experiment 4. Water of crystallization.
- Experiment 5. Common impurities in drinking water.

Unit III—Chemical Change, Elements, Compounds and Mixtures
- Experiment 6. Types of chemical changes.
- Experiment 7. Electrolysis of water.

Unit IV—The Structure of Matter

Unit V—Symbols, Equations, Weight Relation, and Volume Relation

Unit VI—The Periodic Classification

Unit VII—Acids, Bases, Salts, and Ionization
- Experiment 8. Preparation and properties of hydrochloric acid.
- Experiment 9. Properties of acids.
- Experiment 10. Properties of bases.
- Exepriment 11. Properties of salts.
- Experiment 12. Nitric acid.
- Experiment 13. Conductivity of solutions.
- Experiment 14. Neutralization.
- Experiment 15. Hydrogen sulphide.
- Experiment 16. Sulfur dioxide and sulfurous acid.

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[1] See form in Appendix.

[2] B. S. Hopkins, L. W. Mattern, W. Segerblom, and N. E. Gordon, "An Outline of Essentials for a Year of High-school Chemistry," *Journal of Chemical Education*, 13:175-79, April, 1936.

[3] Tentative Courses of Study in General Science, Biology, Physics, and Chemistry For Indiana High Schools. 1933.

[4] J. Carter Eavey, "A Laboratory Manual Using Chemicals and Apparatus Found in the Home, on the Farm, and Locally." (Unpublished Master's thesis, Indiana State Teachers College, Terre Haute, Indiana, 1935.)

[5] University of Illinois, Urbana, Illinois.

[6] McKinley Technical High School, Washington, D. C.

[7] Phillips Exeter Academy, Exeter, New Hampshire.

[8] The Johns Hopkins University, Baltimore, Maryland.

[9] B. S. Hopkins, L. W. Mattern, W. Segerblom, and N. E. Gordon, *op. cit.* p. 3.

[10] J. Carter Eavey, *op. cit.* p. 3.

Experiment 17. Chemical behavior of sulfurous acid.

Unit VIII—The Nature of Non-Metallic Elements.

Experiment 18. Preparation and properties of oxygen.

Experiment 19. Preparation and properties of hydrogen.

Experiment 20. Preparation and properties of nitrogen.

Experiment 21. Preparation and properties of chlorine.

Experiment 22. Preparation and properties of ammonia.

Experiment 23. Sulfur.

Experiment 24. Iodine.

Unit IX—Carbon, Carbon Dioxide, and Carbon Monoxide

Experiment 25. Carbon.

Experiment 26. Carbon dioxide.

Experiment 27. Baking powders.

Experiment 28. Fuels and flames.

Unit X—The Nature of Metallic Elements

Experiment 29. Weight change on heating a metal in air.

Experiment 30. Softening hard waters.

Experiment 31. Compounds of sodium.

Experiment 32. Compounds of calcium.

Experiment 33. Compounds of copper.

Unit XI—Organic Chemistry

Experiment 34. Dry or destructive distillation.

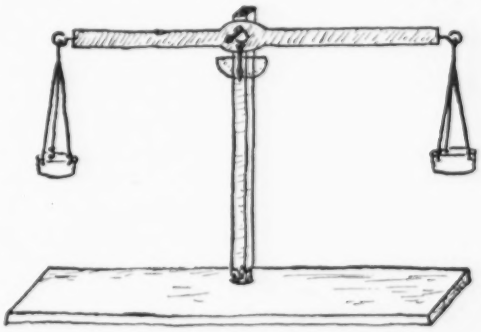
III. Equipment

A. HOME-MADE APPARATUS

The fundamental apparatus as presented here is essential for the performing of the experiments as given in the course of study in Chapter II.

Counterpoise (balance)

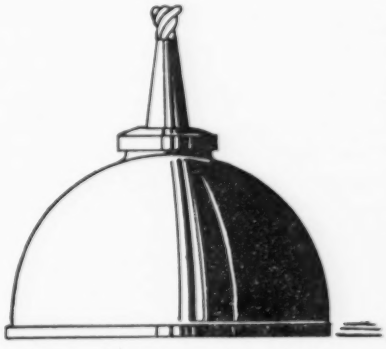
The balance is an essential part of the biology or general science laboratory. However, if none is available, one can be constructed as follows: Drill a three-fourths inch hole in the center of a board which is twelve inches long, five inches wide, and one inch thick. Taper one end of an upright piece of wood which is about one inch square and fourteen inches long. Drive the tapered end into the base which has already been made so that it is at right angles to the base. Drive a nail in the side of the other end so that it is parallel to the base. For the balance beam, a board twelve inches long, two inches wide, and one inch thick may be used. In the center of the beam, drill a hole and whittle it out so the top of the hole is an acute angle. Line this



hole with tin so that it will not bind on the nail fulcrum. By fastening screw-eyes in either end of this beam, buckets or jar lids may be suspended so as to make weight pans. The apparatus may be balanced by shaving the wood off of the heavy side of the beam. A pointer and paper scale may be made to attach to the beam and upright respectively.

Alcohol Burner

Cut the end of the spout from a commmon medium-sized oil can, making a large enough opening to insert the wick which may be made from a used (soft)

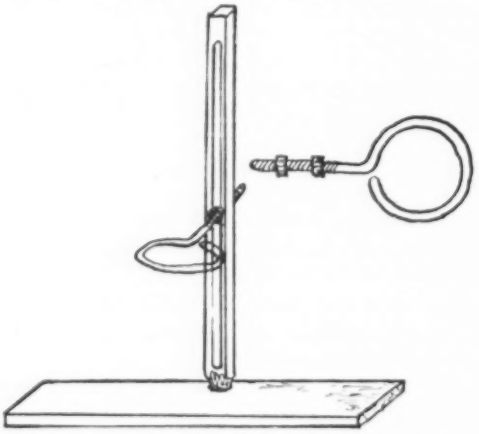


clothesline. A cap can be made from toothpaste sample tubes or bottle caps which will fit the end of the spout snugly.

Ringstand

Drill a three-fourths inch hole in the center of a board twelve inches long, three and one-half inches wide, and one inch thick. This should be near one side of the board as illustrated. Taper the end of an up-

right similar to the one used in making the counterpoise and drive it into the base. Cut a slot in the upright about eight inches long and wide enough to allow a one-half inch iron rod to slide upward or downward easily. Bend a rod which has been thread-



ed on one end to a distance of about two and one-half inches into a form similar to a screw-eye so that the diameter is about three inches. Fit two nuts on the ring so that one may be on either side of the upright to hold the ring in place. Washers may be placed on the inside of each nut to prevent the upright from being worn away due to frequent adjustment.

Other Equipment

E vaporating pans—Ball and Mason fruit jar lids with the porcelain removed.

Cover glasses—Two inch squares cut from ordinary window glass.

Electrodes—Discarded lead-in telephone wire with insulation intact where it is to be immersed in solution.

Gas or still generator—Oil can and copper gasoline line with adhesive tape to hold intact.

Wide-mouthed medicine bottles.
Coal oil lamp.
Light socket and bulb.
Sand paper.
Splints of wood.
Copper wire.
Fruit jar lids.
Water glasses.
Stone jar.
Iron wire.
Stirring rod.
Candle.
Stoppers (cork).
Medicine droppers.
Pan.
Lens or reading glass.

B. CHEMICALS FOUND IN THE AVERAGE HOME

Following is a list of the chemicals necessary to perform the experiments in the course of study presented in Section II. It is thought that a knowledge of the common names to them will be helpful in procuring them for the chemistry course.

	Scientific Name	Common Name
1	Sodium chloride	table salt
2	Sulfur	flowers of sulfur
3.	Sulfuric acid	"A"-battery acid
4	Copper sulfate	blue vitriol, blue stone
5.	Ammonium hydroxide	household ammonia
6.	Acetic acid	vinegar
7.	Potassium permanganate	substance used in drinking water for baby chicks
8.	Zinc	Ball and Mason fruit jar lids
9.	Calcium hydroxide	lime water
10.	Magnesium sulfate	epsom salts
11.	Sodium hydroxide	lye
12.	Lactic acid	sour milk
13.	Sodium bicarbonate	baking soda
14.	Hydrochloric acid	(made by reaction of sulfuric acid on salt) muriatic acid
15.	Ferrous sulfide	(made by heating surfur and iron filings)
16.	Iron filings	(machinist's lathe filings)

17. Potassium alum phosphate----------alum
18. Sodium oleate----------soap
19. Calcium carbonate----------chalk
20. Sodium tetraborate----------powdered borax
21. Sodium bicarbonate----------washing soda
22. Sucrose----------sugar
23. Starch ----------potatoes
24. Sulfur ----------brimstone
25. Sodium bitartrate----------cream of tartar
26. Calcium sulfate----------plaster of paris
27. Silicon dioxide----------sand
28. Iron ----------nails
29. Carbon ----------charcoal or soot
30. Aluminum silicate----------clay
31. Cellulose ----------cotton goods
32. Sawdust
33. Coal
34. White lead paint
35. Blue calico

C. CHEMICALS WHICH MAY HAVE TO BE PURCHASED

The estimated cost of all the chemicals is a small item since the entire list may be purchased for approximately $6.00.

1. Potassium permanganate
2. Litmus paper
3. Silver nitrate solution
4. Tincture of iodine
5. Sulfuric acid (concentrated)
6. Copper sulfate
7. Manganese dioxide

IV. Sample Experiments

The experiments that are included in this section are taken from the thesis written by Eavey and are presented here to give the reader an idea as to how the apparatus and chemicals mentioned in Section II may be used. One representative experiment is taken from each unit in the course of study for the practical chemistry course.

A. EXPERIMENT 1. CHANGES IN MATTER

Purpose: To study chemical and physical changes.

Apparatus: Sandpaper, splints of wood, copper wire, sodium chloride, water, old can lid from a fruit jar, a burner, and a water glass.

Source of Apparatus: Sandpaper is found in most homes as it is used for many general purposes. Splints are easily made from an old piece of pine wood or any easily split wood. The wood should be cut into lengths of six or seven inches and then split as finely as possible. The copper wire can be secured from an old discarded telephone cord or a wire from an old discarded auto cable, by scraping the insulation from the wire. The sodium chloride is nothing more than common table salt. Water from a well, cistern, or stream is available most anywhere. If a zinc lid with a porcelain lining is used to evaporate the liquid in (c), this lining should be removed before using the can lid. It is probable that the burner will be an alcohol burner. If it is, it may have to be purchased.

According to the law of conservation of matter, the amount of matter never varies but changes in matter are going on all the time. Ice melts and water evaporates. Such changes are physical changes. Coal burns and metals tarnish. These are chemical changes because the substances lose their identities and acquire new characteristics. Many times heat and light are instrumental in starting such changes.

(a). Sandpaper a piece of copper wire and examine it. What is its appearance? ———————.

Hold the sandpapered part in a hot flame for a short time. What is the scale that is formed when copper is heated?————————. Bend the copper wire. Compare the properties of copper and the new substance

found. ———————————————
———————————————.
What kind of change is this?————————.

(b). Repeat, using a wood splint. What happens when the splint is put into a flame?———————————————.
Extinguish and allow to cool. Examine. What is the substance on the part held in the flame?———————————————
How does heating of copper compare to the heating of a wood splint?————————.

(c) Take a small amount of water and place a small amount of salt in it. What happens to the salt?———————————.
Place the can lid over a flame and heat until almost all of the liquid has evaporated. There will be enough of heat left in the can lid to complete evaporation. Taste the residue. What is it?————.
Is it a chemical or physical change?———.
Why? ———————————————.

(d). Fill a can lid about half full of water. Heat it until it boils. Hold an inverted larger cool glass over it. What collects on the inside of the larger vessel?——.
What kind of a change is this?————.
Give reasons for your answers.————
———————————————.

B. EXPERIMENT 3. SOLUTION AND SUSPENSION

Purpose: To study the difference between solution and suspension.

Apparatus: Two small tumblers, salt, stirring rod, chalk, clay, large water glass and potassium permanganate.

Source of Apparatus: The tumblers are found in the kitchen and so is the salt. The stirring rod would be better if made of glass, but one made from a light-weight piece of wood, whittled to the size of a small flag stick would work. This should be thoroughly coated with paraffin to such a distance as would be immersed in the liquid. The paraffin is found in the kitchen as it is used in jelly-making. The clay is common soil found on most farms.

Some substances dissolve readily in the water and others more slowly. Others do not dissolve but remain suspended in the liquid. Some suspensions seem to be soluble, but by proper manipulations can be proven that they are suspensions.

(a). In one glass, place a piece of salt (preferably rock or hard salt) and in another put a piece of chalk. Stir each. which one disappears from view?————.

(b). Place a small amount of salt in a glass and put in enough water to dissolve the salt. Stir thoroughly until all salt is dissolved. Is the solution clear and transparent?———————————. Dissolve two crystals of the potassium permanganate in a glass. (There are some farms where tablets of medicine are put into the water for chickens. They contain potassium permanganate and will give the desired color.) Is the solution clear?————.
Is it transparent?————————. Is the color uniform?————————. What does this indicate about the distribution of the solid (solute) in the water (solvent)?
———————————————.
———————————————.
Let it stand for some time. Does the color settle out?————————. Why?————
———————————————.

(c). In a large glass put a lump of clay and fill the glass about half-full of water. Stir for some time. Is the resulting liquid transparent?————————.
Is it clear?————————. Is the color uniform?———————————— .
Allow the liquid to stand for ten of fifteen minutes. Does the clay settle out?———.
Is this a solution?————————. What is it?————————. Why?————.
Give the three characteristics of a true solution as observed from this experiment.
———————————————.
———————————————
———————————————
———————————————

C. EXPERIMENT 7. ELECTROLYSIS OF WATER

Purpose: To study the composition of water.

Apparatus: Stone jar, water, electrodes, bottles to fit over electrodes, insulated wire, acetic acid or vinegar (or battery acid could be used), and a splint.

Source of Apparatus: Most any farm home will have at least one stone jar of gallon size that is generally used around the milk house. Water is plentiful from a well or cistern, and most all homes have a collection of discarded bottles from which two may be selected with mouths large enough to fit over the electrodes. The elec-

trodes are secured from discarded insulated telephone wire of about 14 gauge or larger that is being used for lead-in-wires to the telephone. This insulation must be unbroken where it is immersed in the solution Two pieces are necessary, each about two feet long. The insulation is scraped from one end and then it is bent into a small "T" shape, just small enough to go into the mouth of the bottle. Enough insulation is removed from the other end to make a connection to the source of the current. Do the same with the other wire. Bend one wire into a double "L" so that a portion may be clamped to the rim of the jar, the interior end bending back and up so it just reaches inside the mouth of the bottle. Repeat with the other wire. From this point follow later instructions. The splints have already been prepared for Experiment 1, etc.

The apparatus just described is to be saved for further experiments.

Water was an element to the early Greeks and early alchemists. It remained so until 1781, when Cavendish burned hydrogen in air and found that water was formed. It was found to be composed of two gaseous elements in the 19th century by Dumas.

This experiment should be performed by the class as a whole.

In a stone jar, place a solution of vinegar water. Set up the apparatus as described above. Fill the bottles with the solution and place your hand over the mouth of each bottle and invert into the solution in the stone jar. Place each bottle over each electrode without letting any of the solution out of the bottle. Connect a 6-volt storage battery with the apparatus. If electric current from a storage light plant is used, reduce the voltage to 6 and proceed as before. One electrode will be the anode (+), the other, the cathode (−).

As soon as the water in one bottle has been displaced by gas, remove, keeping the mouth downward. Bring a burning splint to the mouth of the bottle. Result?

_____.

When the other bottle is filled, close and remove from jar inverting at the same time. Thrust a glowing splint into the gas. Result? _____

_____.

What gas collects at the anode?_____. Does the same gas collect at the cathode?

_____.

Refill the bottles with water from the stone jar and repeat. How does the of gas at the cathode compare with the amount at the anode?_____

_____.

There is as much acid at the end as at the beginning. Where do the gases come from? _____

Experimentally, of what is water composed? _____

_____.

Complete the equation:

Water_____→ _____+_____

D. EXPERIMENT 8. PREPARATION AND PROPERTIES OF HYDROCHLORIC ACID

Purpose. To study hydrochloric acid and its common properties.

Apparatus: Sulfuric acid, table salt (NaCl), bottle, stopper, copper tubing.

Source of Apparatus: Sulfuric acid can again be secured from a discarded storage battery, and table salt from the kitchen. The bottle can be an old discarded medicine bottle with a large mouth. The generator is constructed as follows: Drill or burn two holes in the stopper. Into one put a straight piece of copper tubing that has either been shellaced or paraffined on the inside. This can be done by pouring melted paraffin through the heated tubing. In the other hole insert another piece of copper tubing treated in the same manner. Bend this tubing to connect with the bottle in which hydrochloric acid is collected. The end of the tubing should be just above the level of the water in the receiving bottle.

Hydrochloric acid occurs, naturally, in the stomach of people. It is artificially made by man. Mixing salt and sulfuric acid produces hydrogen chloride gas. This is dissolved into water to make hydrochloric acid. Hydrochloric acid is the stronger of the three main laboratory acids, yet kinder to man in the action on flesh.

(a) Into the generator place about 10 grams of salt and 10 grams of sulfuric acid (battery acid). Close with a stopper equipped with a delivery tube, and pass the gas

into another bottle filled with water. Be sure the delivery tube is just above the surface of the water. (Caution: Do not smell the hydrogen chloride gas as it affects the mucous membranes of the eyes, nose, and throat.) If necessary, warm the generator in a pan of water.

Of what two elements is hydrochloric acid composed?———————————————.

Is hydrogen chloride the same as hydrochloric acid?———————————————.
Why? ———————————————.
Complete the equation: $NaCl + H_2SO_4$———→ ——— + ———

Explain why the hydrogen chloride gas is not collected over water.———————————————.

Moisten a piece of litmus paper with the solution just made. Result?———————————————.

Taste the liquid. Result?———————————————.

(b) Place a piece of zinc from an old can lid in a bottle, and pour over it enough of the hydrochloric acid just made to cover it.

If no action takes place, warm the generator in a pan of water. Result?———————————————. Bring a flame near the mouth of the bottle. Result?———————————————

Complete the equation: $Zn + HCl$———→ ——— + ———

What becomes of the metal?———————————————.
Where does the gas come from?———————————————.
Name three characteristic of acids.———————————————.

E. EXPERIMENT 18. PREPARATION AND PROPERTIES OF OXYGEN

Purpose: To prepare and study the properties of oxygen.

Apparatus: Apparatus for the electrolysis of water, four bottles, cover glasses, piece of charcoal, sulfur, splint, and iron wire.

Source of Apparatus: The same electrolytic apparatus is used as in Experiment 4. The bottles may be discarded medicine bottles or any discarded bottle with a mouth large enough. Cover glasses are cut from discarded window glass into squares of about two inches. This size will cover the mouth of most ordinary bottles. Cut at least five or six in number of these for each student as they are used very frequently. Charcoal is easily secured from a place where a brushpile has been burned. and sulfur as in Experiment 3 from the medicine chest. Splints were made in Experiment 1 and should be made in quantities to last several weeks. Iron wire is found almost any place about a farm.

Oxygen can be prepared in many ways. A mixture of $KClO_3$ plus MnO_2 can be heated to get oxygen. HgO when heated will give off oxygen. Electrolysis of water is an inexpensive practical way to prepare oxygen. Oxygen occurs in large quantities in and on the earth, both combined and free.

Set up the apparatus as described in Experiment 4. (This experiment may be successfully performed by groups or an entire class as a unit.) Each group of students should be allowed to collect at least four bottles full. The bottles should be covered with a glass plate and should be placed mouth up on the desk. Why?———————————————.

Give the physical properties of oxygen as observed from the bottles of oxygen.———————————————.

(a) Take a piece of wire about sixteen inches or eighteen inches in length and wrap one end around a piece of charcoal. Lower the carbon into the bottle of oxygen at ordinary temperature. Result?———————————————.

Remove the carbon, replacing cover glass, and heat the carbon until it glows and immediately lower it into the same bottle of oxygen. Result?———————————————.

Compare the intensity of glowing in air to that in oxygen.———————————————.

Equation: Carbon + Oxygen———→ ———

(b) A piece of No. 10 to 13 wire and an old teaspoon make a very good deflagrating spoon, if the handle of the spoon is bent up and the wire is fastened to the handle.

Place a small amount of flowers of sulfur on the spoon and lower the sulfur into the bottle at ordinary temperature. Result?———————————————.

Remove from bottle, replacing cover glass, and heat until it ignites. Lower into

the same bottle of oxygen. Result?———— ———————————————.

Describe the burning of sulfur in oxygen. ———————————————— ———————————————.

What gas is probably formed in the bottle? ———————————————.

After the mist has settled, *cautiously* smell the gas. Name it.———————— ———————————————.

Equation: Sulphur + Oxygen————→ ————.

(c) Take a piece of stranded iron wire (picture wire) or several pieces of fine iron wire. Place it in another bottle of oxygen at ordinary temperature. Result?———— ———————————————.

Remove and heat until it glows. Dip the wire in some flowers of sulfur. Lower into the same bottle of oxygen. Describe what happens. ———————————————— ———————————————.

Equation: Iron (Fe) + Oxygen————→ ————.

(d) Hold a splint in a flame until it burns. Blow out the flame, but be sure the splint glows. Thrust this glowing splint into the last bottle of oxygen. Result?—— ———————————————.

Repeat until it no longer bursts into flame. How many times did it burst into flame? ———————————————.

What is a good, simple, reliable test for oxygen? ———————————————— ———————————————.

F. EXPERIMENT 26. CARBON DIOXIDE

Purpose: To prepare and study the properties of CO_2.

Apparatus: Generator (as in preceding experiment), 3 bottles, splint, and candle.

Source of Apparatus: All things used in this experiment have been used in some one of the preceding experiments and can be used again or obtained in the same manner.

Carbon dioxide is a by-product of all complete combustion. It is exhaled from the lungs of animals. It can be prepared from marble or any carbonate and acid. Small quantities can be collected by burning wood, etc. It is rapidly becoming used in many industries.

(a) Into a bottle of air lower a burning splint. Let burn a short time and remove splint. Add a few c. c. of lime water and shake. Result?———————————— ———————————————.

Add a few drops of HCl. Result?———— ———————————————.

Equations:

$C + O^2$————→ ————.

$Ca(OH)_2 + CO_2$————→ ———— + ————.

$CaCO^3 + HCl$————→ ———————— + ————.

(b) With a tube exhale several times through a solution of lime water. Result? ———————————————.

Add HCl. Result?———————————. What does this show about our bodies? ———————————————.

(c) Repeat (a) using a candle. Tabulate results below: ———————————————— ———————————————.

(d) Into the generator place a few marble chips and add vinegar or HCl. Collect two bottles of the gas by downward placement of air. Into one bottle thrust a burning splint. Result?———————— ———————————————.

Into another bottle place a lighted candle and pour the second bottle of CO_2 in this bottle as you would water. Result?———— ———————————————.

Give as many physical and chemical properties as you can of CO_2 gas.———— ———————————————. ———————————————.

G. EXPERIMENT 30. SOFTENING HARD WATERS

Purpose: To study how to soften hard waters.

Apparatus: Two lids, two bottles, soap solution, magnesium sulfate (epsom salts), and powdered borax or washing powder.

Source of Apparatus: The lids are old discarded fruit jar lids. To use, the porcelain lining should be removed. The soap solution is made by dissolving some finely shaved ivory soap in rain water or distilled water. The soap solution need not be standardized because it is used only to test for comparative hardness.

Water from most sources is known as hard water due to the dissolved minerals. This makes it unfit for some purposes and difficult to use for others, such as washing, because it curdles the soap; for boilers,

because it deposits a scale; etc. Hard water requires more soap than soft water because it is necessary to precipitate the minerals with soap before a suds will form.

(a) Evaporate a few c.c. of distilled (battery) water on a lid and a few c.c. of tap or well water, on another. Is there any residue left from either?———. What is the residue?———.

(b) Add one drop of soap solution to a small amount of distilled water in a small bottle. If a permanent suds is not formed (one that will last for at least 4 minutes) add another drop and shake again.

To the same amount of tap water or well water add a drop of soap solution and shake. Does a permanent suds form?——

———.

If not, keep adding more soap solution, drop by drop and shaking until a permanent suds forms. Which is hard water?

———.

Why? ———.
What is the other water?———

———.

How many drops were necessary to form a permanent suds in the well water?———. Would this indicate it would be classed as a hard water?———. Why? ———.

(c) Repeat using water to which has been added some magnesium sulfate (epsom salts). Does this require as much or more soap solution as well water?———. Why? ———.

(d) Repeat using water to which has been added some powdered borax or washing powder. Results?———. Why is hard water undesirable for use in a laundry?———

———.

Name two ways of softening hard water.

———

———.

Name at least two reasons why hard water is unfit for use in boilers.———

———.

H. EXPERIMENT 34. DRY OR DESTRUCTIVE DISTILLATION

Purpose: To study the process of dry distillation.

Apparatus: Sawdust, small water tumbler, generator as in Experiment 12.

Source of Apparatus: The sawdust can be secured around a work bench or a local sawmill; the small water tumbler from the kitchen. The generator is the same as is used in Experiment 12.

Many products are prepared by dry or destructive distillation. Some are prepared on the commercial scale. For example, coal is distilled destructively or dry for gas, but many by-products are secured which are now as important or more so than gas. Tar is secured which is the basis for perfumes, flavoring extracts, dyes, and many other things. So destructive or dry distillation is commercially important today.

Fill the oil can about one-fourth full of sawdust and close. Place over a flame. Heat slowly at first, then increase the heat until the distillate begins to form. Catch a small amount of the distillate in a small bottle, water tumbler, or can lid.

(a) Smell of the distillate. Describe its odor. ———

———.

Test it with litmus paper, both red and blue. Result?———

———.

From your reading, what does the distillate contain? ———

———.

Why is a distillate secured, when sawdust will generally burn and leave just ashes? ———

———.

V. Conclusions

As has been stated previously, the object of this bulletin is threefold: (1) to aid the chemistry teacher in selecting and designing experiments that will be of minimum expense to the school and of maximum interest to the students, (2) to show that a high school chemistry course does not necessarily involve a large outlay of money, and (3) to establish a medium through which the chemistry teachers of the State of Indiana may exchange ideas.

It is earnestly suggested that any ideas for the better and more economical teaching of chemistry be sent in for future publication.

INFORMATION BLANK

Please fill out the blank with your suggestions and send to Dr. P. D. Wilkinson, Indiana State Teachers College, Terre Haute, Indiana.

Name _____
School _____
Address _____

EQUIPMENT

Explanation

_____
_____
_____
_____
_____
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_____
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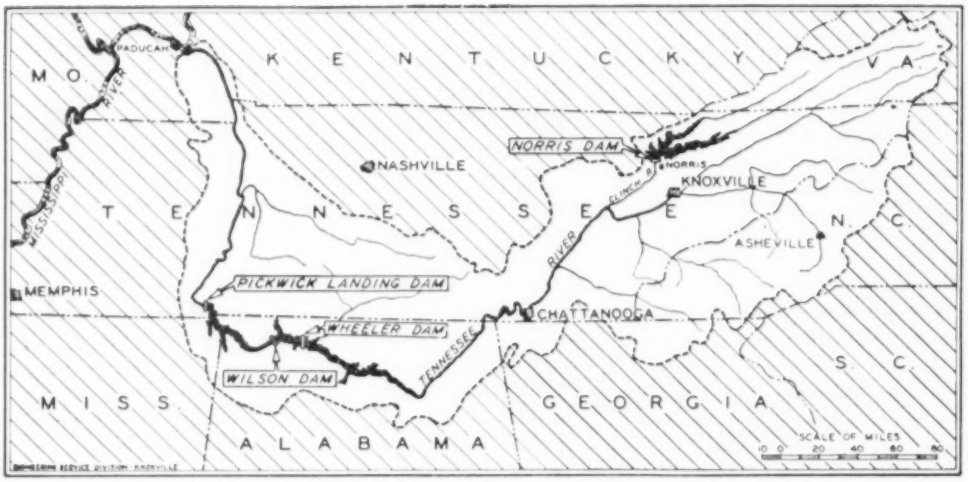
_____

Diagram

To what unit and experiment does it apply?_____

Remarks _____
_____
_____



Tennessee Valley Authority Area Outlined. (Map from Annual Report of the Tennessee Valley Authority, 1936.)

Regional Planning and Land Conservation in the TVA

A Visit to the TVA

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This note on the TVA has been prepared after a week's visit to the region in the spring of 1936*. During that brief period of time, the author spent a day in the field with a mapping party of the land classification section. This section is directed by Dr. G. Donald Hudson, formerly of the University of Chicago, assisted by about fifteen or twenty trained geographers. Likewise a half day was spent in the offices of the section seeing the maps and talking with some of the men who are working on various geographic projects within the TVA.

Another phase of the visit was to travel through some of the different types of regions included within the TVA. The Norris Dam was visited and there were two trips through the Great Smoky Mountains. After spending several days in the Knoxville-Great Smoky Mountain region, the author and his companion moved over to Nashville, crossing the Clinch River into the Nashville Basin. This lowland is in many ways similar to the luxuriant and fecund "Blue Grass" region of Kentucky. The dissected highland area known as the Cumberland Plateau was traversed and then came the journey down into the Cumberland River region, with a return by way of Kentucky to Terre Haute.

It is the purpose of this paper to present very briefly some of the experiences of this trip, and to summarize from the literature, some of the objectives of the TVA. At the end of this article will be given a brief bibliography concerning the TVA.

In starting, an apology is necessary for having the temerity to write upon the work of the TVA after such a brief visit. It is the author's feeling, nevertheless, that here in Indiana, where we are so close geographically to the TVA, that this write-up may encourage some teachers and other citizens to go there and see for themselves the splendid and inspiring work which the TVA is carrying on. The writer willingly assumes responsibility for any errors that may have crept into this paper and begs that you consider in judging it, the briefness of the visit.

The Tennessee Valley Authority as outlined in the Act approved by the 73rd Congress and signed by President Franklin D. Roosevelt on May 18, 1933, reads, "to improve the navigability and to provide for the flood control of the Tennessee River; to provide for reforestation and the proper use of marginal land in the Tennessee Valley; to provide for agricultural and industrial development of said valley; to provide for the national defense by the creation of a corporation for the operation of Government properties at and near Muscle Shoals in the state of Alabama, and for other purposes." As listed in the annual report of the TVA *navigation and flood control, fertilization* program and *national defense, electricity* program, *planning* and *demonstration* services, and *management service* activities, are the most important phases of the work of the Authority program.

In 1929 the Federal Government prior to any mention of the TVA issued a general plan for the control of water resources of the Tennessee River system with the purpose in mind of flood control, aid to navigation, and the development of power.

Dr. A. H. Morgan (one of the three directors of the TVA) writing in the March,

*Dr. L. J. Rettger, head of the science department of Indiana State Teachers College, accompanied the author on this visit.

1935, issue of the *Survey Graphic*, states: "Land planning is not new. A few years ago I was engaged on an irrigation project in the west where it was necessary to plan a system of irrigation canals. Some of these canals followed the locations of old Pueblo Indian canals, which according to the saga of the Pueblo Indians nearby, antedated the coming of Columbus by more than four hundred years. Considerable intelligent planning was necessary to produce such a system."

Dr. Morgan continues in the same article, "The inherent possibilities of America are practically unlimited. It is the purpose of the TVA within a limited area to try to plan the use of natural resources and so to guide and encourage the energy and intelligence of the people, that these resources so change poverty, unemployment, and relative aimlessness and hopelessness for young people into effective, economic productivity and prosperity." This certainly is a clear statement of desirable outcomes for any Government project.

With regard to planning he says, "The TVA is undertaking a program of land use planning as a foundation for a social and economic program. This program is in charge of Earl S. Draper and a staff of more than a hundred men working the fields of architecture, town planning, highway planning, and regional planning. No effort is being made to produce suddenly a plan of land use for the Tennessee Valley as a whole."

In this relation one might say that land use planning is made up of three essential elements: First, intelligence, experience, and imagination co-ordinating to create a picture or a vision of what is possible or desirable. The ultimate goal is often controlled by such vision. Second, the collection and organization of facts is necessary. Third, the application, adjustment, and integration of these ideals to meet the individual and particular cases is essential.

Mapping

As basis of such a land planning program, naturally, a good topographical map of the region is necessary. One has been prepared and is constantly being improved and brought up-to-date in cooperation with the United States Coast and Geodetic Survey, with the United States Geological Survey, and other federal agencies. After the main network of levels and horizontal controls had been established, a series of airplane photographs was secured. In general, these are the five lens aviation photographs, although certain regions have been mapped utilizing the one lens camera. A tremendous region may be photographed in a short period of time, but it takes several months to reduce or enlarge the the photographs, to match, and to make a complete areal mosaic. This substantially slows down the work. These basic topographic and aviation maps will be supplemented by forest survey maps, soil survey maps, and geological resource maps, in addition to the detailed land utilization maps prepared by the land classification section.

Soil Erosion

The soil erosion program is of tremendous importance, not only for the conservation of the existing top soil, but likewise because this finely divided rock material will be swept and washed off the slopes by gullying and sheet erosion. It then will be carried by the rushing waters down into the dam reservoirs. There it will silt up seriously the lakes above the dams, thus reducing the acre-foot water capacity of the proposed reservoirs. It likewise in time will result in making a delta where formerly a lake existed. The recent disastrous floods are a terrible warning of what lies ahead of a denuded region. The experiences in large areas in China, now barren bad lands, are eloquent testimonials of lack of foresight and conservation.

Planning and Demonstration

Under the section planning and demonstration services, the writer was particularly interested in the land planning work, and it was Dr. Hudson, chief of the land classification section, who was visited during the stay in the TVA. He has been engaged recently in the work of rural land classification, where he has about fifteen geographers along with draftsmen and clerical assistants. His section is part of the division of land planning and housing. All of this land inventory mapping work is done from cars and no unit of less than two hundred acres is mapped because too much detail would needlessly complicate the gen-

eral pattern of the country as shown on the maps.

Forestry

The forestry planning and demonstration section is bound to be of considerable importance because the TVA includes many regions formerly important hardwood areas. This is a district which has been cut over extensively by the old time exploitation method, and as a result has been subject to very serious gullying and top soil denudation. The writer understands that the forestry work is progressing very favorably. Soon the TVA may be seen as a typical region protected for the pleasure and use of future generations under the splendid leadership of the Federal Government.

Agriculture

The section on agricultural planning and demonstration is doing a most interesting piece of work. It is moving people off the poor land; it is acting as a protective agency to prevent erosion of land which is on the verge of being rendered useless; and it is rehabilitating certain farm areas on the borderline of being destroyed by gullying and sheet erosion.

Other Activities

In Ceramics, research is being carried on which may prove of value in the stimulation of new industries for the valley inhabitants.

Certain work in cooperatives is being started but little has been done so far along this line.

National Security

From the point of view of national security and national defense value these hydro-electric projects located in the interior of the United States are important. They make possible the production of nitrates and of elemental phosphorous as well as phosphates which from the point of view of national security are of prime importance. For this alone much of the money spent in the TVA would be entirely justified in view of the increasingly serious international situation in Europe and the Far East.

Resume

To the author the most interesting phase of the work is the planned utilization of our natural resources and the intelligent and careful employment of these resources in increasing the sum total of happiness and hope for Americans in this region.

Bibliography

Chase, Stuart. "Behind the Drought." *Harpers.* 173:368-77, September, 1936.

——— *Rich Land, Poor Land.* McGraw-Hill Company, New York, 1936. 361 pp.

Eckel, Edwin C. *Engineering Geology and Mineral Resources of the Tennessee Valley Authority Region.* June, 1934. 25 pp.

Ferris, John P. *Some Relationships of Industry to Agricultural and Population Readjustment.* Tennessee Valley Authority, Knoxville, Tennessee, June 20, 1935. Mimeographed. 21 pp.

Frank, Bernard. "Forestry Application by the Tennessee Valley Authority." *Journal of Forestry,* 33:851-56, October, 1935.

Hudson G. Donald. "Geography and Regional Planning." *Journal of Geography.* 34: 267-77. October, 1935.

——— "The Unit Area Method of Land Classification." *Annals of the Association of American Geographers.* 26:99-113, June, 1936.

Lentz, Gus. "Making Water Walk in the Tennessee Valley." *American Forests,* 40:200-2, May, 1934.

Morgan, Arthur E. "Bench-Marks in the Tennessee Valley." *Survey Graphic,* 24:113-16, 529-32, March, November, 1935.

——— "Social and Economic Implications of T. V. A." *Civil Engineering,* 5:754-7, December, 1935.

Morgan, Harcourt A. "National Program in the Tennesseee Valley." *Instructor,* November, 1934. pp. 53-9 (Also in mimeograph form.)

Richards, Edward C. "Role of Forests in the Tennessee Valley." *American Forests,* 40:471-73, October, 1934.

Tennessee Valley Authority Annual Report, 1935. U. S. Government Printing Office, Washington, D. C., 1936. 90 pp.

Tennessee Valley Authority. Division of Forestry. "Forestry in the Tennessee Valley," Tennessee Valley Authority, Knoxville, Tennessee, October, 1934. 8 pp.

Woolrich, W. R. *Effects of Technological Improvements upon Regional Planning.* Tennessee Valley Authority, Knoxville, Tennessee. July 3, 1935. Mimeographed. 12 pp.

———————. Industry and Agriculture in the Tennessee Valley Development. Mimeographed, February 21, 1935. 10 pp.

———————and Ferris, J. P. *Some Responsibilities of Industry in Agricultural-Industrial Readjustment.* Tennessee Valley Authority, Knoxville, Tennessee. November 13, 1934. Mimeographed. 12 pp.

Note: Mimeographed material and many of the reprints may be secured from the information section of the Tennessee Valley Authority, Knoxville, Tennessee.